DOE/NETL Mercury Control Technology Development Program

IEACCS
Biomass Co-Firing and Coal Fired Power Generation

Pisa, Italy

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www.netl.doe.gov

Potential Mercury Regulations

MACT Standards

- Likely ≤ 90% Hg reduction
- Compliance: 2007

Clean Power Act of 2001

- 4-contaminant control
- 90% Hg reduction by 2007

Clear Skies Act of 2002

- 3-contaminant control
- 46 % Hg reduction by 2010
- 70% Hg reduction by 2018
- Hg emission trading

President Bush Announcing Clear Skies Initiative February 14, 2002

Why Have Power Plants Been Targeted for Hg Emissions Control?

- **Mercury (Hg) is the hazardous air pollutant of greatest concern:**
  - Hg is a neurotoxin
  - bioaccumulates in food chain
  - humans exposed to methylmercury through fish consumption
- **Other industrial sources regulated:**
  - municipal waste combustors
  - medical waste incinerators
- **Based on 1999 ICR data, coal-fired power plants contribute about one-third of annual U.S. anthropogenic Hg emissions (about 49 tons/year)**

Coal-Fired Utility Plants
Boiler and APCD Information

- **Types of Boilers (1140 units)**
  - Pulverized coal-fired: 979 units
  - Cyclone-fired: 87 units
  - Fluidized-bed combustors: 42 units
  - Stoker-fired: 32
- **Flue gas cleaning methods***
  - ESPs only: 787 units
  - FFs only: 79 units
  - Dry scrubbers: 43
  - Wet FGD scrubbers: 143
  - Other: 88 units

*38 units with SNCR and 6 units with SCR

Coal Use and Mercury Emissions

Coal type	Dry tons burned, 1999	Percent of total burned *	Total mercury emitted, tons	Percent of total emitted
Bituminous	427,572,000	56	25	52
Subbituminous	279,227,000	36	17	36
Lignite	50,932,000	7	4	9

* For wet tons (as received), total is 928,398,000 tons (vs. 768,487,000 dry tons)
Percentage for wet tons is 50% bituminous, 41% subbituminous, 8% lignite

What Is NETL's External Program?

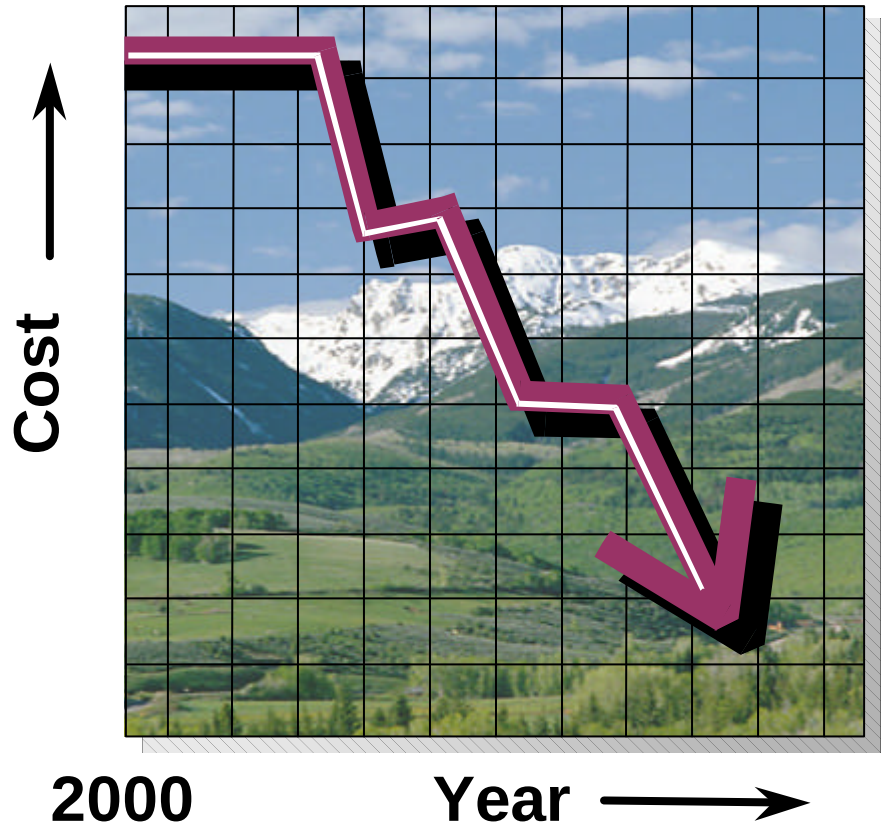
- **In response to the 12/14/00 EPA regulatory determination regarding control of Hg and related HAPs from utility boilers, DOE/NETL is :**
  - Conducting field-scale testing of Hg control technology to develop cost and performance data
  - Initiating pilot-scale testing of advanced Hg (multi-pollutant) control concepts
  - Mercury Cost and Performance Modeling

R&D Goals

DOE Mercury Control Program

Have technologies ready for commercial demonstration:

- **By 2005, reduce emissions 50-70%**
- **By 2010, reduce emissions by 90%**
- **Cost 25-50% less than current estimates**



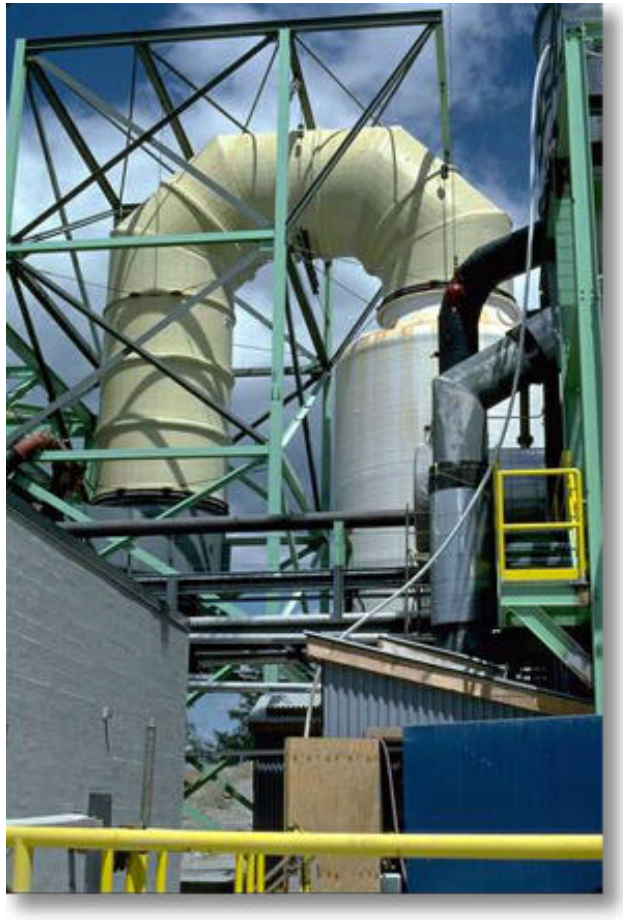
Baseline Costs: $30,000 - $70,000 / lb Hg Removed

Technology Approach

- **Augment existing control technologies**
  - Add sorbent upstream from baghouse or electrostatic precipitator
  - Spray-Cooling
- **Oxidize elemental mercury and capture in a flue gas desulfurization unit**

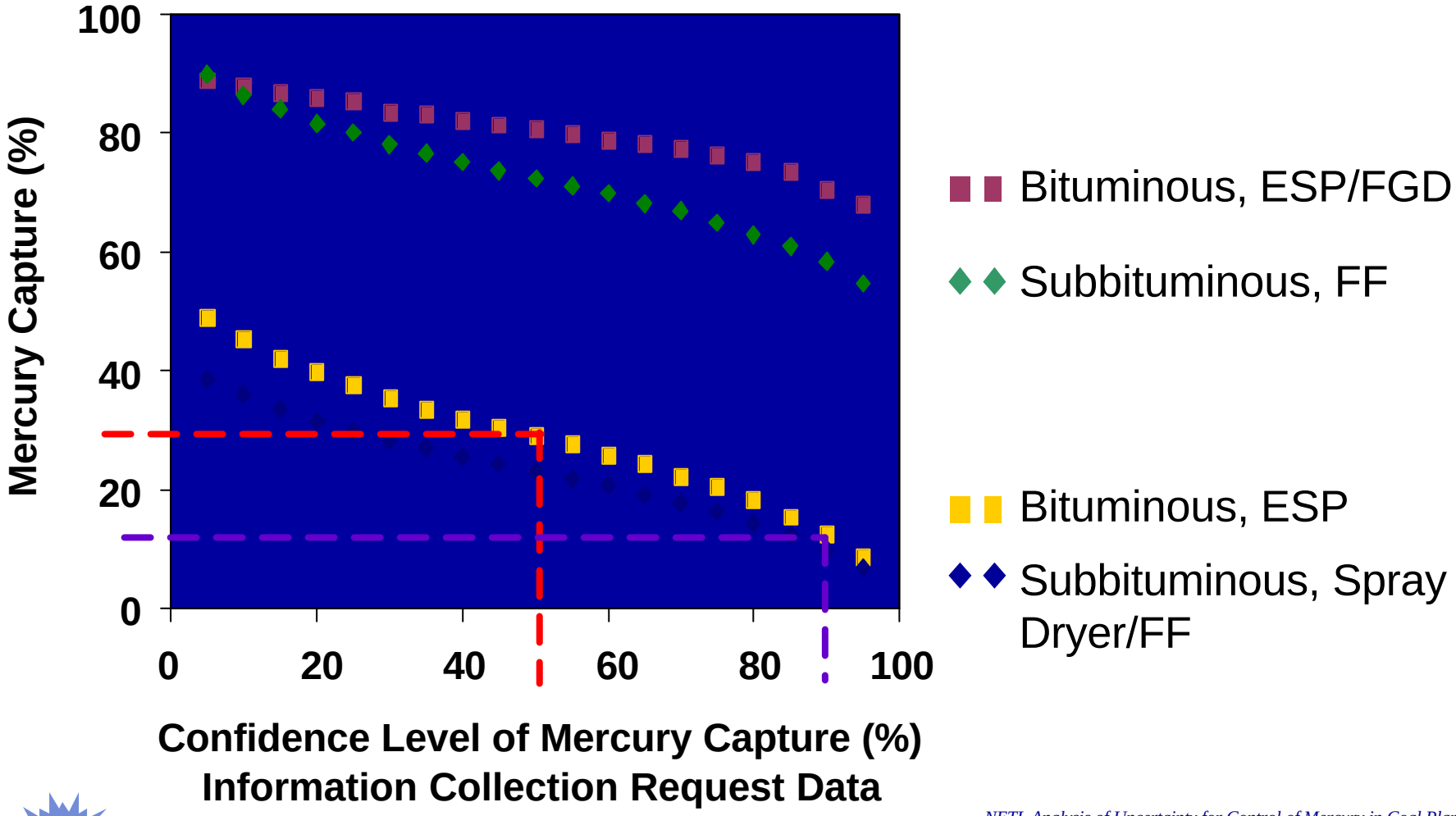
SCR + FGD Not Necessarily the Solution

- **Plant 1 – Bituminous coal**
  - 25% Hg oxidation across SCR
  - 98% total oxidized Hg
- **Plant 2 – Bituminous coal**
  - 31% Hg oxidation across SCR
  - 88% total oxidized Hg
- **Plant 3 – Subbituminous coal**
  - 5% Hg oxidation across SCR
  - 10% total oxidized Hg



ICR Data Uncertainty

Confidence of Performance for Mercury Control



Uncertainties
Mercury Control Technologies

- **Balance-of-plant impacts**
- **By-product use and disposal**
- **Capture effectiveness with low-rank coals**
- **Confidence of performance**

Capturing Mercury Is Difficult!

Houston Astrodome

A Hypothetical Example

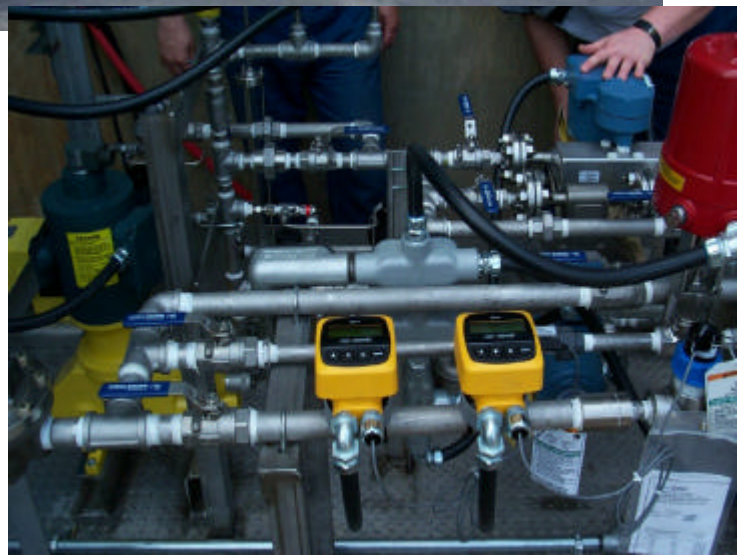
- **Dome filled with 30 billion ping pong balls**
- **30 mercury balls**
- **Remove 27 balls for 90% Hg capture**

Six Mercury Control Field Tests

Technology / Utility Plant	Start Date
ADA-ES – Sorbent Injection	
Alabama Power – Gaston	March 2001
We Energies – Pleasant Prairie	September 2001
PG&E – Brayton Point	June 2002
PG&E – Salem Harbor	September 2002
McDermott-B&W – Enhanced Scrubbing	
Michigan South Central Power – Endicott	May 2001
Cinergy – Zimmer	October 2001

Current Mercury Control Focus

- **Operating plant tests**
  - **ADA Environmental Solutions, LLC**
    - ADA-ES has completed three of four planned field tests of sorbent injection technology at power plants that have either electrostatic precipitators (ESP) or fabric filters
  - **B&W/McDermott Technology, Inc.**
    - B&W/MTI finished testing of proprietary liquid reagent in two different sizes/types of wet FGD downstream of an ESP



ADA-ES Field Test Sites

Alabama Power – Gaston

- 135 MW
- Low-sulfur bituminous coal
- ESP
- COHPAC fabric filter

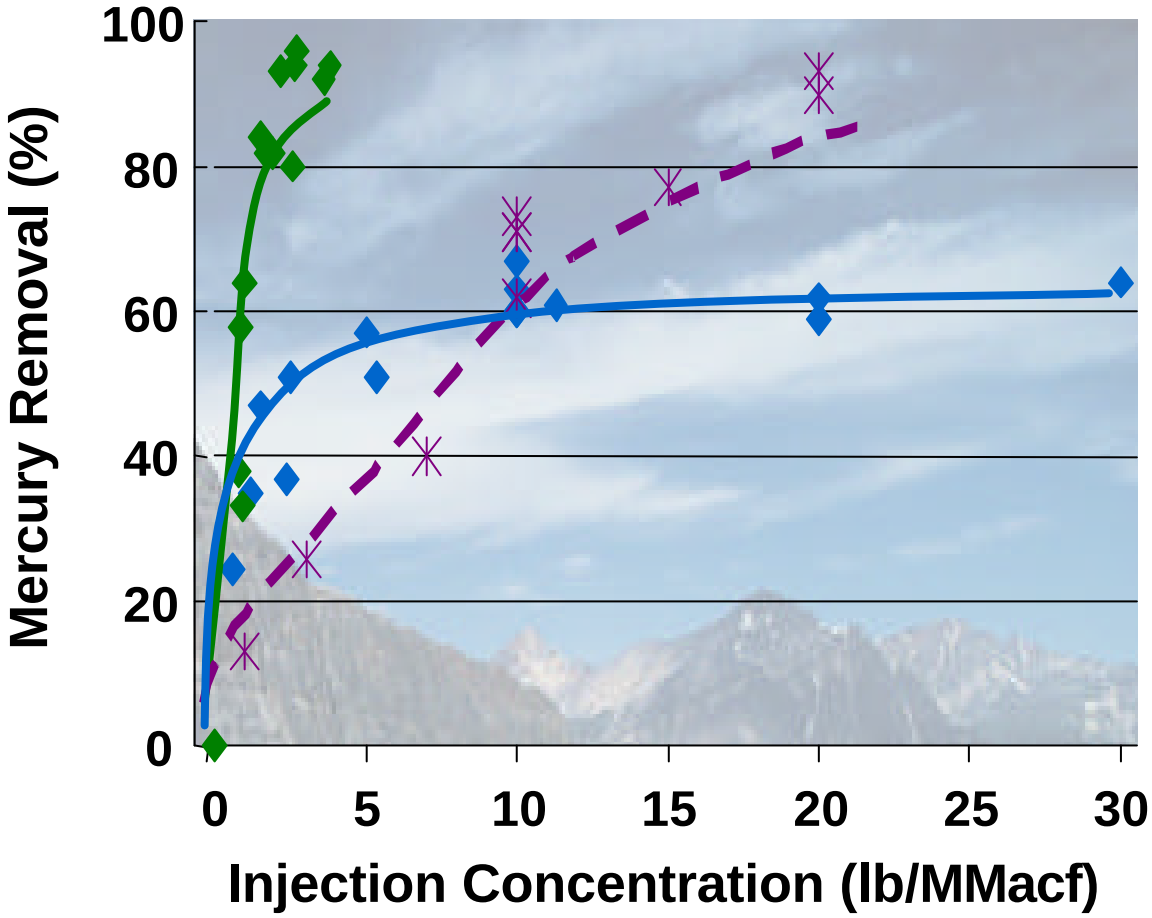
We Energies – Pleasant Prairie

- 150 MW
- Subbituminous coal
- ESP

PG&E – Brayton Point

- 122 MW
- Low-sulfur bituminous coal
- Low-NO_X burners
- Two ESPs in series

Mercury Removal Trends
Activated Carbon Injection



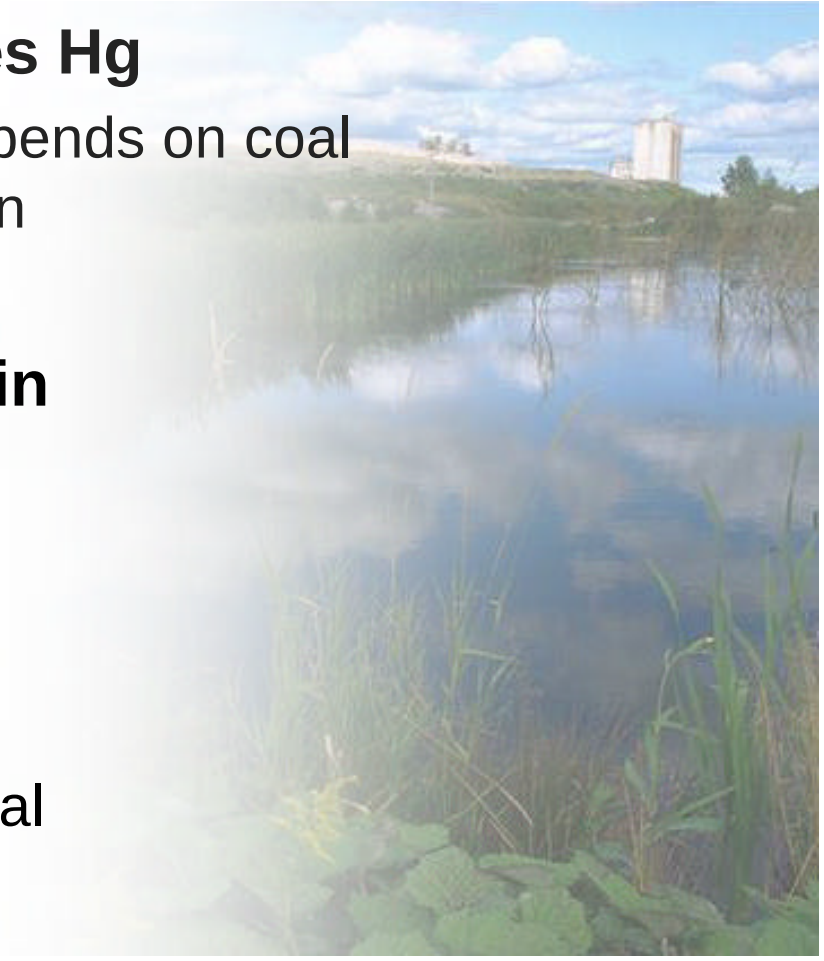
Gaston: **Bit., ESP**

Brayton Point: **Bit., ESP**

Pleasant Prairie:
SubB., ESP

Observations From Field Tests

- **Activated carbon removes Hg**
  - Range of effectiveness depends on coal type and plant configuration
- **Many uncertainties remain**
  - Low-rank coals
  - Sorbent costs
  - Units equipped with ESPs
  - Downtime for startup
  - By-product use and disposal



Mercury Control Technology Field Testing
B&W/MTI Enhanced Scrubbing

- **Host Sites:**
  - *Michigan South Central Power*
    - Endicott - 55 MW, limestone forced oxidation
    - High-S bituminous coal
  - *Cinergy*
    - Zimmer - 1300 MW, thiosorbic lime
    - High-S, bituminous coal

B&W Field-Test Summary

FGD System Gas Phase Hg Removal, %	Endicott	Zimmer
Average	79	51
Range	67 to 84	38 to 69
Average Coal Mercury, lb/10^{12} Btu	14	12
Stack Hg Emissions, lb/10^{12} Btu	1.1 to 5.3	3.6 to 8.4

General Assessment of Wet FGD Mercury Control Potential

FGD mercury control variation reflects:

- Coal / mercury speciation differences
- System design differences (tower configuration, SO_2 removal, L/G)
- System chemistry (forced oxidation / natural / inhibited)

Enhanced FGD is cost effective approach for co-control

- Limited additional hardware
- Low reagent use rate

Mercury control efficiency

- 90% possible for bituminous coal – but it's a stretch currently
- 50 to 70% readily achievable for bituminous coal sites
- Integrated Hg^0 oxidation – catalytic or chemical?
- Must control re-emission of Hg^0

Impact on By-Products Could Be Significant

Fly Ash

- 63M tons / yr generated
- 32% used
- Utilization loss for concrete ≤ $390M impact

FGD By-Product

- 25M tons / yr generated
- 19% used
- Utilization loss for wallboard ≤ $135M impact

Fly Ash

FGD By-Product

Hazardous Designation of All By-Products Would Cost $11 Billion / Year

Long-Term Field Testing Key Research Need

- **Competitive solicitation in FY 03**

- **Seeking stakeholder input:**
  - Coal types
  - Plant size and configuration
  - Testing duration
  - Application of CEMs

Other Research Needs

- Implications of global Hg emissions on U.S.
- Improvements in CEMs
- Investigation of Hg impacts on coal by-product use and disposal
- Continued development of advanced Hg control concepts

Advanced Mercury Control Concepts

- **Apogee Scientific**
  - Advanced Hg sorbents
- **CONSOL**
  - Multi-pollutant control for Hg, SO_2, and acid gases
- **EERC**
  - Hybrid particulate control system
- **Powerspan**
  - Multi-pollutant control for Hg, SO_2, NO_x, particulates, acid gases
- **Southern Research Institute**
  - Calcium-based additives to control Hg
- **URS Group**
  - Catalyst to convert elemental to oxidized Hg

Designed to Achieve [3] 90% Hg Removal

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